What is Claimed is:

1. A method of forming an antenna beam with a phased array antenna comprising an array of antenna elements, the method comprising:

selecting a plurality of angular directions at which nulls are to be located in an antenna radiation pattern of the phased array antenna;

computing a radiation shaping transformation as a function of the selected angular directions; and

determining from the radiation shaping transformation an amplitude and phase distribution over the array of antenna elements that forms the antenna beam with nulls of the antenna radiation pattern at the selected angular directions.

2. The method of claim 1, wherein computing the radiation shaping transformation comprises:

constructing a plurality of vectors corresponding to the selected angular directions at which the nulls are to be located; and

computing a matrix whose product with each of the vectors is zero;

wherein the amplitude and phase distribution is determined from the matrix.

3. The method of claim 2, wherein the phased array antenna comprises M antenna elements, k angular directions are selected at which nulls are to be located, and the matrix is an MxM matrix of rank M-k.

4. The method of claim 1, further comprising:

applying amplitude tapering to the phased array antenna to reduce sidelobe levels of the antenna radiation pattern relative to a uniform illumination radiation pattern.

5. The method of claim 4, wherein the amplitude and phase distribution determined from the radiation shaping transformation reduces a width of a main lobe of the antenna beam pattern relative to the width of the main lobe resulting from amplitude tapering without the amplitude and phase distribution determined from the radiation shaping transformation.

6. The method of claim 4, wherein the amplitude and phase distribution determined from the radiation shaping transformation increases main lobe power of the antenna beam

pattern relative to the main lobe power resulting from amplitude tapering without the amplitude and phase distribution determined from the radiation shaping transformation.

7. The method of claim 4, wherein the amplitude and phase distribution determined from the radiation shaping transformation reduces sidelobe levels of the antenna radiation pattern relative to sidelobe levels resulting from amplitude tapering without the amplitude and phase distribution determined from the radiation shaping transformation.

8. The method of claim 1, wherein the amplitude and phase distribution determined from the radiation shaping transformation reduces sidelobe levels of the antenna radiation pattern relative to a uniform illumination radiation pattern.

9. The method of claim 1, wherein the amplitude and phase distribution determined from the radiation shaping transformation increases main lobe power of the antenna beam pattern relative to a uniform illumination radiation pattern.

10. The method of claim 1, wherein the antenna beam is a transmit antenna beam.

11. The method of claim 1, wherein the antenna beam is a receive antenna beam.

12. The method of claim 1, wherein computing a radiation shaping transformation includes performing a Gram-Schmidt orthogonalization procedure.

13. A method of forming an antenna beam with a phased array antenna comprising an array of antenna elements, the method comprising:

selecting a plurality of angular directions at which nulls are to be located in an antenna radiation pattern of the phased array antenna;

constructing a plurality of vectors corresponding to selected antenna radiation pattern nulls;

computing a matrix whose product with each of the vectors is zero; and

determining from the matrix an amplitude and phase distribution over the array of antenna elements that forms the antenna beam with nulls of the antenna radiation pattern at the selected angular directions.

14. A method of forming an antenna beam with a phased array antenna comprising M antenna elements, the method comprising:

selecting k angular directions at which nulls are to be located in an antenna radiation pattern of the phased array antenna;

constructing k vectors $v_n$ corresponding to selected antenna radiation pattern nulls;

computing an MxM matrix A of rank M-k that satisfies $Av_n = 0$ for $n = 1, \ldots, k$;

determining from matrix A an amplitude and phase distribution over the array of antenna elements that forms the antenna beam with nulls at the selected angular directions.

15. An apparatus for forming an antenna beam, comprising:

a phased array antenna comprising an array of antenna elements;

a processor that computes a radiation shaping transformation as a function of selected angular directions at which nulls are to be located in an antenna radiation pattern of the phased array antenna; and

an antenna element control module that controls amplitudes and phases of the antenna elements in accordance with the radiation shaping transformation to produce an amplitude and phase distribution over the array of antenna elements that forms the antenna beam with nulls of the antenna radiation pattern at the selected angular directions.

16. The apparatus of claim 15, wherein the antenna element control module comprises a plurality of phase control elements and amplitude control elements respectively corresponding to the antenna elements.

17. The apparatus of claim 16, wherein the amplitude control elements are variable attenuators.

18. The apparatus of claim 16, wherein the amplitude control elements are variable amplifiers.

19. The apparatus of claim 16, wherein the amplitude control elements are linear amplifiers.

20. The apparatus of claim 16, wherein the amplitude control elements are saturated

amplifiers.

21. The apparatus of claim 16, wherein the phase control elements are variable phase shifters.

22. The apparatus of claim 15, wherein the processor computes the radiation shaping transformation by constructing a plurality of vectors corresponding to the selected angular directions at which nulls are to be located, and computing a matrix whose product with each of the vectors is zero, wherein the amplitude and phase distribution is determined from the matrix.

23. The apparatus of claim 22, wherein the phased array antenna comprises M antenna elements, k angular directions are selected at which nulls are to be located, and the matrix is an MxM matrix of rank M-k.

24. The apparatus of claim 15, wherein the antenna element control module applies amplitude tapering to the phased array antenna to reduce sidelobe levels of the antenna radiation pattern relative to a uniform illumination radiation pattern.

25. The apparatus of claim 24, wherein the amplitude and phase distribution determined from the radiation shaping transformation reduces a width of a main lobe of the antenna beam pattern relative to the width of the main lobe resulting from amplitude tapering without the radiation shaping transformation.

26. The apparatus of claim 24, wherein the amplitude and phase distribution determined from the radiation shaping transformation increases main lobe power of the antenna beam pattern relative to the main lobe power resulting from amplitude tapering without the radiation shaping transformation.

27. The apparatus of claim 24, wherein the amplitude and phase distribution determined from the radiation shaping transformation reduces sidelobe levels of the antenna radiation pattern relative to sidelobe levels resulting from amplitude tapering without the radiation shaping transformation.

28. The apparatus of claim 15, wherein the amplitude and phase distribution determined from the radiation shaping transformation reduces sidelobe levels of the antenna radiation pattern relative to a uniform illumination radiation pattern.

29. The apparatus of claim 15, wherein the amplitude and phase distribution determined from the radiation shaping transformation increases main lobe power of the antenna beam pattern relative to a uniform illumination radiation pattern.

30. The apparatus of claim 15, further comprising a transmitter module that generates signals to be transmitted by the phased array antenna, wherein the phased array antenna transmits via the antenna beam the signals generated by the transmitter module.

31. The apparatus of claim 15, further comprising a receiver module, wherein the phase array antenna receives via the antenna beam signals to be processed by the receiver module.

32. The method of claim 1, wherein, in computing the radiation shaping transformation, the processor performs a Gram-Schmidt orthogonalization procedure.

33. An apparatus for forming an antenna beam, comprising:

a phased array antenna comprising an array of antenna elements;

means for computing a radiation shaping transformation as a function of selected angular directions at which nulls are to be located in an antenna radiation pattern of the phased array antenna; and

means for controlling amplitudes and phases of the antenna elements in accordance with the radiation shaping transformation to produce an amplitude and phase distribution over the array of antenna elements that forms the antenna beam with nulls of the antenna radiation pattern at the selected angular directions.

34. A communication device, comprising:

a phased array antenna comprising an array of antenna elements for forming an antenna beam;

a processor that computes a radiation shaping transformation as a function of selected angular directions at which nulls are to be located in an antenna radiation pattern of the phased array antenna;

a transmitter module that generates signals to be transmitted by the phased array antenna;

a receiver module that processes signals received by the phased array antenna; and

an antenna element control module that controls amplitudes and phases of the antenna elements in accordance with the radiation shaping transformation to produce an amplitude and phase distribution over the array of antenna elements that forms the antenna beam with nulls of the antenna radiation pattern at the selected angular directions, wherein the phased array antenna transmits and receives signals via the antenna beam.